

---

## CHAPTER 5 ENERGY FOR AIR TRANSPORTATION

### 5.1 Air Transportation and Hawaii

Air transportation is vital to Hawaii. Overseas air transportation is essential to Hawaii's tourism-based economy, providing transportation to millions of visitors annually. Overseas air transportation is the only regular passenger connection to the mainland United States and international destinations for Hawaii's citizens.

Interisland air transportation is equally critical. It is the only passenger connection between Hawaii's islands for residents and visitors alike. As Hawaiian Airlines aptly noted, "One-third of this market is represented by residents of Hawaii who rely on interisland flights in much the same way as Mainland residents rely on a state highway system" (Hawaiian Airlines 1997).

The importance of air transportation in Hawaii is borne out by comparing its jet fuel use in 1995 to other states. Hawaii ranked 40th nationally in population, but 8th in the amount of jet fuel used. On a per capita basis, Hawaii (14.76 Bbl per capita) ranked second to Alaska (28.03 Bbl per capita) (DBEDT 1999 and EIA 1997).

The significance of air transportation is further highlighted by the fact that four Hawaii city-pairs rank in the top 22 airline markets in the United States. Honolulu-Kahului is ranked 2nd, Honolulu-Lihue is 15th, Honolulu-Kona is 21st, and Honolulu-Hilo is 22nd. Among overseas routes, Honolulu-Los Angeles is the 19th busiest domestic city-pair market and Honolulu-Tokyo is the 6th most traveled international city-pair market (Lampl 1997).

#### 5.1.1 Interisland Airlines

Aloha Airlines and Hawaiian Airlines are Hawaii's primary interisland carriers. Currently, Aloha operates 18 Boeing 737-200 aircraft. The Hawaiian Airlines fleet includes 15 DC-9-50 aircraft in its interisland operations. In addition, Hawaiian has 12 DC-10-10 aircraft used in scheduled service to the mainland United States and South Pacific destinations (Carey 1999). Four other small passenger carriers operate smaller aircraft. One of these small carriers is Island Air, a subsidiary of Aloha Airlines. Island Air operates DeHavilland Dash-6 and Dash-8 turboprop aircraft.

Interisland passengers numbered 10,448,099 in 1997, up 5.5% from 1990 levels. This represented a decline of 133,726 (1.2%) from the 1996 peak of 10,581,825 passengers (DBEDT 1998f). Additional detail is provided on Table A-14 in Appendix A.

The aggregate interisland load factor for Aloha Airlines and Hawaiian Air increased by 5% from 57.3% in 1990 to 60.1% in 1996. About 3% less fuel was used to provide the increased service, increasing the average available seat miles per gallon (ASM/gallon) to 27.3.

While Mainland airlines with newer equipment and longer routes achieve over twice the ASM per gallon, the shorter flights of the interisland carriers are inherently less efficient. These short flights require high fuel use for takeoff and

climb to cruising altitude that is not amortized by long cruise and descent segments, which characterize many longer Mainland routes operating similar equipment. As Table 5.1 shows, the lengths of interisland flights range from 54 to 214 statute miles (DBEDT 1998f). As noted above, the 98-mile Honolulu-Kahului city-pair has the second highest volume of all city-pairs in the United States (Lampl 1997).

<b>Table 5.1 Distances from Honolulu International Airport</b>	
<b>Airport</b>	<b>Statute Miles</b>
Hilo Airport, Hawaii	214
Kona Int'l Airport, Hawaii	168
Lihue Airport, Kauai	103
Kahului Airport, Maui	98
Lanai Airport, Lanai	72
Molokai Airport, Molokai	54

DBEDT 1998e

### **5.1.2 Overseas Air Transportation**

In 1997, there were 25 carriers conducting overseas operations to and from Hawaii. Twelve were domestic carriers and 13 were foreign carriers (DBEDT 1998f). Since 1990, overseas air carriers operating between Hawaii and the mainland United States and a variety of international destinations have increased their load factors. During the 1990s, the number of estimated westbound arrivals decreased by 1% and eastbound arrivals decreased by 3%. While the reduced numbers of passengers have had negative effects on Hawaii's tourism industry, the increased load factors, coupled with increased efficiency as newer aircraft are used on Hawaii routes, has increased fuel efficiency and reduced greenhouse gas emissions.

Table A.15 provides an estimate of the number of available seats and passengers between overseas destinations and Hawaii based upon U.S. Department of Transportation data compiled by BACK Information Services. The data included revenue passengers on virtually all scheduled airline flights, but did not include charter flights. Since anecdotal information indicates that many westbound passengers come to Hawaii using frequent flyer benefits, the load factors are likely understated. Based upon the available data, the average load factor of overseas flights to Hawaii improved by 7% from 1990 to 1997.

Load factors on routes to and from Hawaii are high compared to overall U.S. airline load factors, which averaged 69% in 1996. In addition, according to information compiled by DBEDT economist Chris Grandy, monthly westbound load factors were 90% or greater for eight months over the three years 1995–1997 (Grandy 1999). When non-revenue passengers are considered, it appears that any future improvements in fuel efficiency on westbound overseas routes will have to come primarily through the use of more efficient aircraft or improved operating techniques. In addition, traffic growth can be expected to partially offset reductions in greenhouse emissions achieved through greater efficiency.

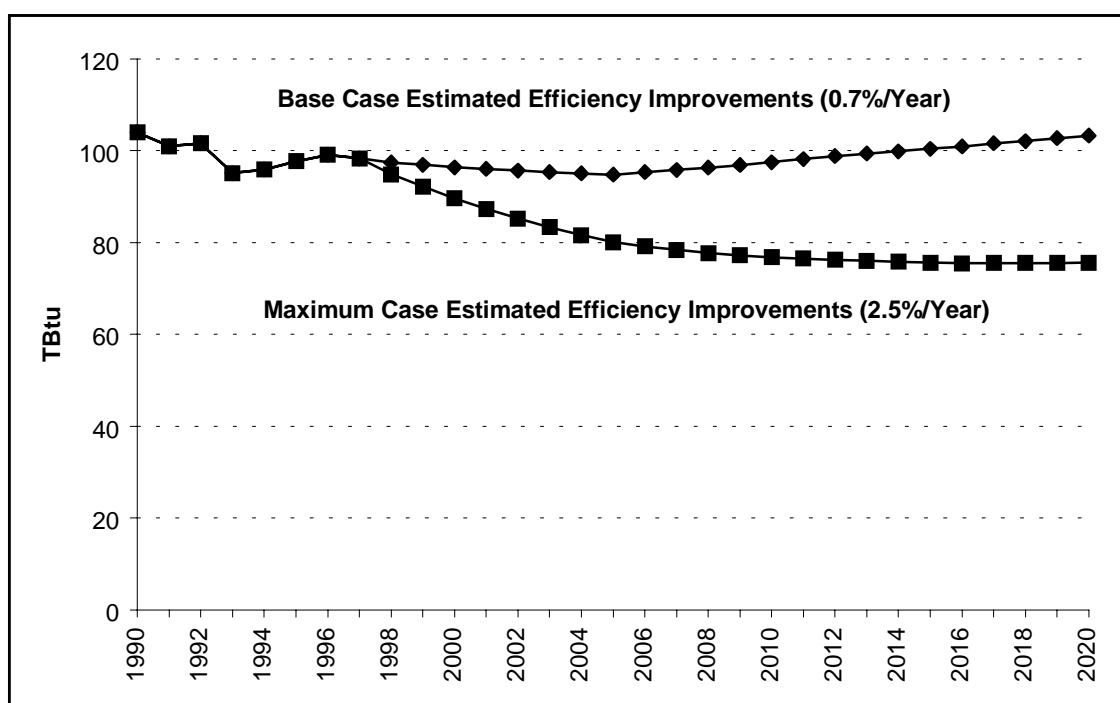
## 5.2 Air Transportation Energy Demand

### 5.2.1 Current Aviation Fuel Use

In 1997, 8.442 million barrels of domestic jet fuel were used by civilian scheduled airlines on interisland flights and flights between Hawaii and the mainland United States. Piston-engine aircraft operating in Hawaii used about 32,000 barrels of aviation gasoline. Air carriers on international operations used 8.901 million barrels of bonded jet fuel. The military purchased 735,290 barrels of jet fuel from Hawaii refiners or distributors, but that fuel was not necessarily used by Hawaii-based aircraft. In this report, as in the *Hawaii Climate Change Action Plan* (DBEDT 1998b), only domestic jet fuel and aviation gasoline were used in calculating total Hawaii greenhouse gas emissions. Table A.16 details estimated jet fuel use or sales in each of these categories for the years 1990–1997.

### 5.2.2 Future Aviation Fuel Requirements

This section provides an estimate, produced by the ENERGY 2020 model, for future civilian jet fuel use for both domestic and international operations. Since military jet fuel purchases from Hawaii refiners followed no consistent pattern in recent years, such purchases were not estimated. Aviation gasoline use was small and was not estimated.



**Figure 5.1 Actual and Forecast Jet Fuel Sold or Distributed in Hawaii for Civilian Use, 1990–2020**

Figure 5.1 shows forecast amounts of jet fuel sold or distributed in Hawaii for civilian use from 2000 to 2020. The base case efficiency estimate was based on the USDOE best estimate of an average efficiency improvement of 0.7% per year

---

starting in 1998. About 103.9 TBtu of jet fuel were required in 1990. Although efficiency improved, growth in traffic overcame most of the efficiency improvements in the base case, resulting in an estimated need for 103.2 TBtu in 2020, a value 99% of the 1990 level.

If maximum estimated efficiency improvements occur (on the order of 2.5% per year), jet fuel use would decline from 103.9 TBtu in 1990 to 75.6 TBtu in 2020, a 27% decrease. Maximum forecast aircraft efficiency improvements could reduce civilian jet fuel demand in Hawaii by as much as 28.4 TBtu, less than the base case, by 2020. This could have significant implications for Hawaii refiners, which maximize jet fuel production, and for consumers of other refined products. It would also significantly contribute to reducing greenhouse gas emissions.

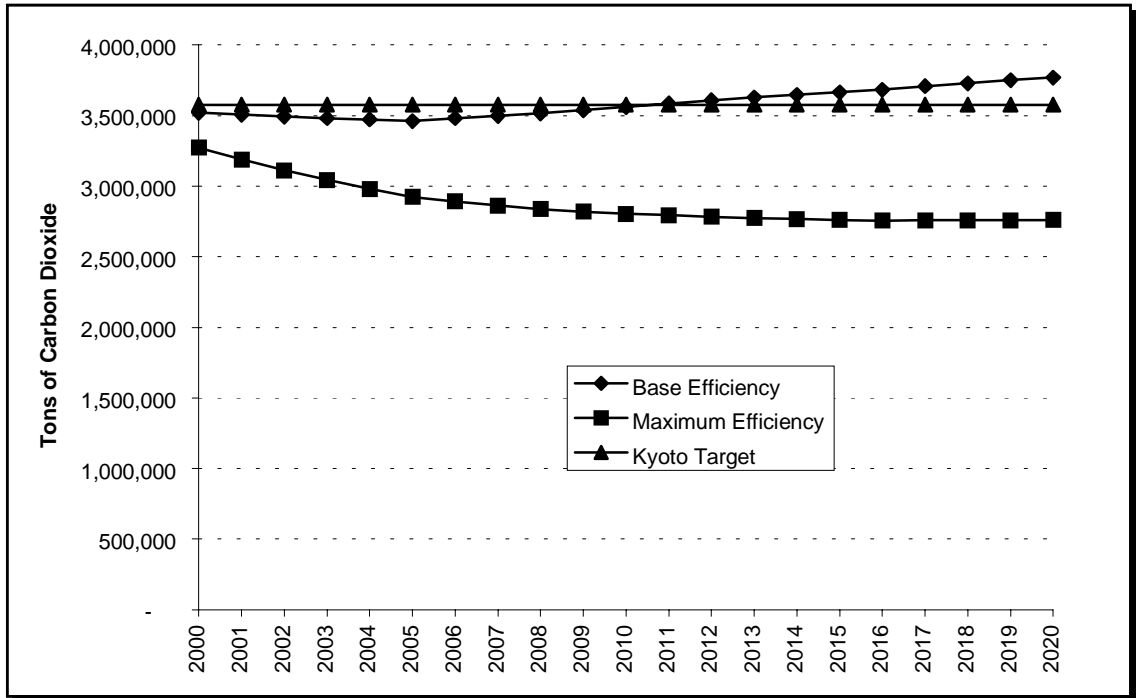
### 5.3 Greenhouse Gas Emissions from Aviation Fuel Use

The use of aviation fuel produces a number of pollutants. Due to their contribution to global warming and climate change, greenhouse gas emissions are of particular concern in *Hawaii Energy Strategy 2000 (HES 2000)*.

In the *Hawaii Climate Change Action Plan* (DBEDT 1998b), the focus was on emissions from domestic aviation operations. Under the Intergovernmental Panel on Climate Change (IPCC) guidelines for preparing national inventories of greenhouse gas emissions, international aviation and marine bunker fuel were to be recorded as separate categories and were not included under the national total (Michaelis 1997a, 20). The *Action Plan* and *HES 2000* followed that practice and did not count international aviation (bonded) and military fuel sold or distributed in Hawaii in their calculations of Hawaii's greenhouse gas emissions. Table A.17 provides details on the greenhouse gas emissions from all of these categories.

Figure 5.2 presents two estimates of future CO<sub>2</sub> emissions from Hawaii domestic aviation fuel use produced by the ENERGY 2020 model and compares them to the Kyoto Protocol target of 7% below 1990 emissions by 2008–2012. These correspond to the estimates of fuel use depicted in Figure 5.1, above. It is stressed that the Kyoto Target is shown for reference only. There is no expectation that each sector, let alone each state, will be required to meet the goals specified in the Protocol.

By 2010, the Maximum Efficiency Case (2.5% annual efficiency improvement) was estimated to produce 21.2% less CO<sub>2</sub> than the Base Case (0.7% annual efficiency improvement) and 21.6% less than the Kyoto target. The Base Case was estimated to produce 0.5% less CO<sub>2</sub> than the Kyoto Target. By 2020, due to continued traffic growth, the Maximum Efficiency Case was estimated to produce 26.8% less CO<sub>2</sub> than the Base Case and 22.8% less than the Kyoto target. The Base Case was estimated to produce 5.4% more CO<sub>2</sub> than the Kyoto Target. It is not clear that the maximum efficiency growth rate will be achieved or whether it will offset passenger mile increases as forecast.



**Figure 5.2 Estimate of Greenhouse Gas Emissions from Domestic Aviation Fuel Use in Hawaii, 2000–2020**

## 5.4 Economic Effects of Aviation Fuel Use

### 5.4.1 Cost of Aviation Fuels

As noted above, aviation brings visitors to Hawaii who support its largest industry and provides the passenger links between Hawaii’s islands. As a result, Hawaii’s economy is highly vulnerable to increases in the cost of aviation fuel. In 1995, an estimated \$250 million was spent in Hawaii on jet fuel. This amount does not include the cost of bonded fuel or fuel purchased elsewhere but loaded in Hawaii. About \$9 million was spent on aviation gasoline (DBEDT 1998d, 91). Higher fuel prices would increase the price of tickets, reducing the demand for air travel (DeCicco 1997, 227). This would be very undesirable for Hawaii’s tourism-based economy and for its airline-based interisland transportation system.

Market forces, especially fuel prices, will also be important in determining the efficiency of the future air transport fleet. Higher fuel prices create an incentive to retire obsolete, less-efficient aircraft in favor of newer, more-efficient aircraft.

### 5.4.2 Possible Carbon Taxes

*HES 2000* seeks to identify ways to improve energy efficiency and reduce energy use. Such efforts should also benefit Hawaii’s economy or at least not have major negative effects. Carbon taxes, which would increase the cost of fossil fuel use, are often discussed as potential measures for reducing fossil fuel use and greenhouse gas emissions.

---

Carbon taxes may make sense in those energy sectors where there are currently non-fossil fuel options or where there are further efficiency measures that would become cost-effective at the resulting higher energy price. However, in the air transportation sector, there are no currently available non-fossil-fuel alternatives, and it appears that the industry is already actively pursuing energy efficiency due to the economic value of such efficiency. The use of carbon taxes would likely have major negative consequences on Hawaii's economy.

The Annex I Expert Group on the United Nations Framework Convention on Climate Change published an analysis of the effects of carbon taxes on international aviation fuel in March 1997 (Michaelis 1997a). Michaelis modeled carbon taxes at \$5, \$25, and \$125 per tonne of carbon (one tonne is a metric ton, equal to 2,200 lbs.). These charges equated to roughly 2%, 10%, and 50% of current jet fuel prices. The increased fuel costs were assumed to be passed through to airline customers, resulting in higher fares and lower demand for air transport, and thus lower emissions.

At \$5 per tonne, ticket prices would increase less than one percent, resulting in less than a one-percent reduction in traffic. At \$25 per tonne, ticket prices would rise 1.4% and the number of passengers would decline 0.9% to 2.9%. At \$125 per tonne, ticket prices would be about 7% higher, reducing traffic by 4.4% to 13%. It was also expected that airlines would attempt to mitigate the effects as much as possible by reducing non-fuel costs, by reducing fuel consumption through more efficient operation, and by re-equipping with more efficient aircraft or replacing less efficient engines (7).

#### **5.4.2.1 RECOMMENDATION: Ensure That Proposals for Carbon Taxes on Aviation Fuels Do Not Adversely Affect Hawaii**

##### **Suggested Lead Organizations: Hawaii Congressional Delegation and Legislature**

It is strongly recommended that Hawaii *not* be subject to any carbon taxes on aviation fuels that could adversely affect the State's economy. Any national carbon taxes should take into account Hawaii's lack of alternatives to air transportation for interisland and overseas travel and the potential effects of higher air fares on tourism. Alternative means of increasing the efficiency of air travel should instead be considered.

### **5.5 Reducing Air Transportation Energy Requirements**

#### **5.5.1 Actions Taken to Reduce Air Transportation Energy Demand**

Airlines have considerable incentive to reduce fuel use. Fuel amounts to approximately 15% of total operating expenses, the second largest operating expense. As a result, airlines and aircraft manufacturers have made increased fuel efficiency a top industry priority for many years (ATA 1997).

---

#### **5.5.1.1 ACTION TAKEN: Improved Load Factors**

##### **Lead Organizations: Airlines**

As discussed above, airlines with Hawaii operations improved load factors in the 1990s. By filling higher percentages of available seats with passengers, overall efficiency improved.

#### **5.5.1.2 ACTION TAKEN: Operational Changes**

##### **Lead Organizations: Airlines**

Aloha Airlines provided information that its flight operations department began a fuel efficiency program in 1993. The flight plans between all islands were changed to incorporate a parabolic profile. Aloha's aircraft now climb to higher altitudes and begin descent earlier, at lower airspeeds, to conserve fuel. An aircraft washing program also minimizes dirt on the aircraft, removing a source of drag (Ackerman 1997).

### **5.5.2 Recommendations to Reduce Air Transportation Energy Demand**

#### **5.5.2.1 RECOMMENDATION: Adopt Operating Measures to Increase Fuel Efficiency**

##### **Suggested Lead Organizations: Airlines**

Generally, measures that reduce fuel use will reduce greenhouse gas emissions. There are a number of measures in use by U.S. airlines that have not been implemented in Hawaii. These should be considered by Hawaii's airlines to the extent that they are consistent with applicable Federal Aviation Administration regulations. These include reducing cruising speeds; determining optimum fuel loads and selecting altitudes and routes that minimize fuel burn; using flight simulators rather than real aircraft for pilot training; holding aircraft at gates with engines shut down when weather or other problems delay takeoff; using only one engine to taxi; keeping aircraft exteriors clean to minimize aerodynamic drag (ATA 1997); reducing the use of auxiliary power units and using ground (utility) electrical power instead; and converting airport vehicles and ground service equipment to alternative fuels (NRDC 1996).

#### **5.5.2.2 RECOMMENDATION: Maintain High Aircraft Load Factors**

##### **Suggested Lead Organizations: Airlines**

One of the competitive factors in the interisland market is flight availability and schedule frequency, which reduces the opportunity for increased efficiency through higher load factors. Load factors in overseas operations are at such high levels that increases may not be practical. Since availability of flights to Hawaii for visitors is critical to Hawaii's economy, there is some concern that lack of

---

available flights may have reduced visitor counts over the past few years. Higher load factors could have negative economic effects.

**5.5.2.3 RECOMMENDATION: Re-equip Interisland Airlines with Newer, More Efficient Aircraft**

**Suggested Lead Organizations: Interisland Airlines**

Using newer aircraft on interisland routes could significantly improve fuel efficiency. The average age of Aloha's Boeing 737-200 fleet is 17 years (extrapolated from Lampl 1997, 34), the average age of Hawaiian's DC-9-50 fleet is 21 years, and the DC10-10s on Hawaiian's overseas routes are 26 years old (extrapolated from Hawaiian Airlines 1998).

According to the Air Transport Association of America, "The McDonnell-Douglas MD-80 (now produced in an updated form as the Boeing 717), Airbus A-320, and Boeing 737-300, for example, transport twice as many passengers per gallon of fuel than the DC-9 and earlier versions of the 737. In addition, they emit smaller amounts of the gases of concern to scientists studying global warming and other environmental trends" (ATA 1997).

As Hawaiian Airlines pointed out in its 1996 *Annual Report*, there are important economic and competitive considerations involved in replacing the current interisland fleet. Both Hawaiian and Aloha airlines face equipment replacement decisions early in the next decade. While the airlines could enjoy improved fuel efficiency and reduced maintenance costs, they must meet the purchase or leasing requirements necessary to replace their current fleets. Hawaiian Airlines announced in September 1999 that by the end of 2001 it would replace its 15 DC-9s in interisland service with 13 Boeing 717-200 aircraft. The new aircraft are reportedly 25% more fuel-efficient than the DC-9s they replace (Lynch 1999, A-1).

It is recommended that Hawaii's other interisland air carriers, and any other airlines that may enter the interisland market, give maximum consideration to reducing fuel costs and to maximizing reduction of greenhouse gas emissions through selection of the most fuel-efficient aircraft available. Such new equipment should offer more economical operation while reducing the potential harm that could result from future fuel price increases.

**5.5.2.4 RECOMMENDATION: Use Newer, More Efficient Aircraft on Overseas Routes**

**Suggested Lead Organizations: Airlines and Department of Transportation**

Overseas carriers operate a variety of aircraft of varying vintage. Operating measures similar to those discussed above can improve their fuel efficiency. Operation of newer equipment can also reduce fuel requirements. Another possible action, suggested by the Natural Resources Defense Council, is

---

implementation of differential landing fees based upon aircraft emissions. This would encourage airlines to use their least-polluting aircraft (NRDC 1996).

### ***5.5.3 Future Improvements in Aviation Technology for Energy Efficiency***

Future gains in commercial aviation energy efficiency could be obtained through technological improvements to engines and airframes, and in the more distant future, new technologies for aircraft propulsion. These measures are beyond the control of Hawaii, but they will set the standard for potential future reductions of greenhouse gas emissions from air transportation.

Since the first commercial jet aircraft were introduced in the 1950s, fuel use in the cruising mode for short- to medium-range flights has decreased by 65% and for long-range aircraft by 55%. Seat miles per gallon increased from 26.2 to 48.6, nationally. The main factors behind these improvements are technological improvements in aircraft, a 30% increase in load factors, and an average 40% increase in aircraft size (DeCicco 1997, 210).

In 1992, the National Academy of Sciences set a goal of reducing fuel used per seat mile by 40% over the next two decades. It forecast a 25% reduction from improved engine performance and 15% from aerodynamic improvements and weight reductions (211).